

REMARKS

In view of the foregoing amendments and following remarks responsive to the Office Action of February 13, 2002, Applicant respectfully requests favorable reconsideration of this application.

The invention disclosed and claimed in the present application relates to a dual band RF tuning circuit in which frequency tuning is performed by selectively switching inductors or capacitors in and out of functional connection with the received signals. The particular design allows many of the same circuit elements and functions to be used in different frequency bands without significant performance degradation or increase in size of the circuit. The circuit utilizes matching circuit networks capable of precise tuning to multiple frequency bands.

In accordance with the invention, MESFET transistor switches are used for band selection and are integrally formed with the tuning circuits, whereas known circuits having external switching devices, such as double throw switches and switching diodes. The integral MESFET switches enable fast switching response and low voltage operation compared to the prior art. Further, the MESFET switching circuits are fabricated integrally with the tuning circuit and are of lower inherent impedances than discrete switching devices, which enable precise tuning in multiple frequency bands.

Claims 1-15 were pending in this application. Applicant has herein added new claims 16-21, and amended claims 6, 8, 9, 10, 11, 12, 13, and 14. Accordingly, claims 1-21 are now pending in this application.

The Patent and Trademark Office (Office) rejected all of claims 1-15 under 35 U.S.C. §103(a) as being obvious over Anderson in view Liu. With respect to claims 1, 2, 3, 5, and

7, for example, the Office asserted that Anderson discloses essentially all of the claimed invention and further discloses a filter switching arrangement for a tuner having first and second impedance elements between an RF input port and an RF output port, a band control voltage source, and conducting gates, as disclosed in Col. 1, lines 59-67. The Office noted, however, that Anderson fails to specifically disclose the use of a switching transistor. Instead, Anderson teaches the use of switching diodes.

However, the Office asserted:

In the same field of endeavor Liu et al. discloses half bridge zero voltage switch PWN fly back DC/DC converter. In addition Liu et al. discloses a switching transistor as disclosed in Col. 6, lines 52-58.

Therefore it would have been obvious...to modify Anderson with a switching transistor as taught by Liu et al. for the purpose of having a cheaper and more flexible circuit.

With respect to claims 4, 6, 8, 10, 11, and 12, the Office asserted that Anderson further discloses a resistance 919 connected across the conducting gates of the transistor 901 and the drain and source nodes of the transistor 919 being in series, as disclosed in Col. 3, lines 1-5.

With respect to claim 9, the Office asserted that Anderson disclosed everything claimed as discussed in connection with claim 1.

With respect to claims 13, 14, and 15, the Office asserted that Anderson further discloses that the switching transistor is a FET and an amplifier, as disclosed in Col. 3, lines 25-26.

Applicant respectfully traverses these rejections. In short, Anderson teaches nothing more than what Applicant has already admitted as prior art in the Background section of this application (see the discussion of US patent No. 4,379,269 contained on p. 2, l. 29 - p. 3, l. 25)

and Liu teaches nothing more than that a transistor can be used as a switch, a fact which Applicant readily concedes.

More specifically, Anderson discloses a television tuner, the relevant portion of which is the tunable filter 7 and, particularly, inductors 701, 702, 703, 704, 705, 706, bandswitching diodes 713, 715, and 717, capacitors 719 and 723 and varactor diodes 707a and 707b.

The primary purpose of tunable filter 7 of Anderson's television tuner is to exhibit a band pass amplitude versus frequency response that allows the RF signal corresponding to a channel to be tuned to each RF amplifier 9 while inhibiting other RF signals from reaching RF amplifier 9 (Col. 2, lines 34-38). More particularly, referring to the sole figure in the Anderson patent, tuning diodes 713, 715, and 717 are controlled by bandswitching signals BS1 and BS2 to selectively configure the inductors 701, 702, 703, 704, 706 to adjust the band pass amplitude versus frequency response of tunable filter 7. A secondary purpose of tunable filter 7 is to switch capacitor 723 in and out of the circuit to selectively generate a frequency trap (e.g., at 177 MHZ) to improve tuning performance with respect to television channels 6 and 7 (see Col. 7, l. 3 - Col.8, l. 54).

In essence, Anderson contains nothing relevant beyond that which Applicant has already admitted as prior art in the discussion of US patent No. 4,379,269 contained on p. 2, line 29 - p. 3, l. 25 of the present specification. Like the 4,379,269 patent, Anderson uses switching diodes to adjust the frequency of the tuner. As discussed on p. 3, ll. 17-25 of the present specification, a disadvantage of this type of switching is its unsuitability for low voltage applications, such as personal communication devices, because the switching diode is a discrete circuit element requiring significant voltage for its bias, either forward or backward. Further, the switching diode

is an active device having its own characteristics as a reactive element with capacitance and inductance values that deter the precise tuning of the circuit to different frequency bands.

Anderson's bandswitching diode 713, 715, and 717 essentially are the same diodes and suffer from the exact same problems. For instance, as noted in Col. 5, l. 66 and Col. 6, l. 14, Anderson's bandswitching diodes 713, 715, and 717 require bias voltages on the order of the -12 and +12 volts. This is a requirement that certainly is unacceptable in low voltage circuits.

The Liu reference discloses a half-bridge zero-voltage-switched PWM fly back DC/DC converter in which MOSFET transistors Q1 and Q2 are used as parts of band selecting switches. Accordingly, the Office's assertion that Liu is in the same field of endeavor as the present invention, is quite clearly inaccurate. Liu has nothing to do with RF tuning circuits, but relates to DC/DC voltage converters. Thus, Liu is not proper prior art to the present invention. However, even if one were to assume for the sake of argument that Lie is relevant prior art, its relevance essentially would be limited to the fact that Lie discloses that a transistor can be used as a switch and applicant certainly will not dispute that it is known in the prior art to use a transistor as a switch.

One aspect of the invention of the present application relative to the admitted prior art of the 4,379,269 patent and Anderson comprises replacing the diodes of the 4,379,269 patent and Anderson with MESFET transistors that are fabricated integrally with the RF tuning circuit. This enables fast switching response and low voltage operation. As expressly discussed in the present specification, the MESFET switch transistors have lower inherent impedances than discrete switching devices, which enables precise tuning to multiple frequency bands. Liu clearly does not

teach this. In fact, Liu contains absolutely no impetus to replace Anderson's diodes with Liu's MOSFETs.

The Office's assertion that it would have been obvious to substitute Liu's transistors for Anderson's diodes "for the purpose of having a cheaper and more flexible circuit" is not even accurate. There is actually no reason to believe that such a substitution would make the circuit cheaper or more flexible.

In fact, Liu's switches Q1 and Q2 actually each comprise a diode (and a capacitor, for that matter) in addition to the MOSFET transistor. Accordingly, the substitution of Liu's switches into Anderson actually does not result in the replacement of Anderson's diode switches with transistor switches. Rather, it results in the replacement of Anderson's diode switches with switches that include both diodes and transistors. Accordingly, the proposed combination actually results in a circuit that is more costly, not less costly, and even less flexible than Anderson. Accordingly, using the Office's own logic, the references actually teach away from the proposed substitution since they result in a circuit that is even more costly and less flexible, not less costly, than Anderson.

The advantages of the substitution of transistors, and particularly, MESFET transistors, are those set forth in Applicant's disclosure and repeated above. There is essentially nothing in either of these references that would suggest the proposed substitution. Rather, only improper hindsight reconstruction in view of the present specification leads to the present invention.

Furthermore, nothing in either reference mentions a MESFET transistor or integrally forming the transistor with the rest of the band tuning circuit.

Even further, as alluded to above, Liu is not even in the same field of endeavor and cannot properly be relied upon in this rejection in any event. Liu relates to DC/DC converters and has nothing to do with adjusting the frequency of RF tuning circuits. As a DC/DC converter, Liu is dealing with very high voltages, e.g., on the order of hundreds of volts. Accordingly, it is even less flexible than an unmodified Anderson circuit in that the components are designed to operate at extremely high voltages.

In summary of the above-discussed matters, the proposed combination clearly is not suggested in the prior art. First, the two references are in entirely different fields. Secondly, the references teach away from the proposed combination because the proposed substitution would make Anderson work much less effectively. Finally, the proposed combination does not even result in the present invention in that it lacks the teaching of a MESFET or integrally forming the switching transistor(s) with the rest of the band tuning circuit.

However, even further, the claims of the present application contain some rather specific limitations defining the claimed circuit, which limitations are not found in the references in the first instance. The Office has provided only minimal description of the application of Anderson to the claims of the present invention. Accordingly, Applicant is not certain what component of Anderson the Office believes correspond to which claim limitations. However, even assuming for purposes of argument the substitution of transistors for Anderson's diodes, it is unclear whether the claim 1 limitation of "the switching transistor having conducting gates connect to the second impedance element to short the second impedance element" is met by Anderson. Which of inductors 701, 702, 703, 704, 705 and 706, does the Office consider to be the claimed "second impedance"? Anderson discloses that, in both his bands 1 and 2, inductors 701, 702, 703, 704,

and 705 dictate the response of tunable filter 7, whereas, in band 3, only inductor 705 and 706 dictate the response of tunable filter 7. However, it does not seem that any of the band switching diodes 713, 715, or 717 actually “short” any of the inductors when in the low impedance/conducting state. That is, none of the bandswitching diodes 713, 715, and 717 appears to be in parallel with any of the inductors 701, 702, 703, 704, 705, or 706. Thus, even accepting all of the improprieties of the proposed combination, the limitations of independent claim 1 still would not be met by the prior art of record.

Even further, dependent claim 3 recites that “the first and second impedance element are capacitance impedance elements”. Anderson clearly does not meet those limitations. His impedance elements are inductances.

Further, with respect to dependent claim 6, Anderson clearly does not teach “a resistance connected across the conducting gates of the switching transistor” let alone “the source of band control voltage being connected to a dividing point of the resistance” (see Fig. 2 of the present application) or “the conducting drain and source nodes of the switching transistor being in series connection with the second impedance element to open circuit the second impedance element”. It is clearly seen in the Anderson patent that none of the bandswitching diodes 713, 715 and 717 are connected in series with any of the inductors.

With respect to claim 6 (as well as claim 4 and 8) the Office asserted that Anderson discloses a resistance 919 connected across the conducting gates of the transistor 901 and the drain and source nodes of the transistor 919 being in series as disclosed in Col. 3, lines 1-5 of Anderson. However, transistor 901 and resistance 919 have absolutely nothing to do with the bandswitching diodes 713, 715, and 717. In fact, they have nothing to do with tunable filter 7.

Rather, they are components of RF amplifier 9 and, therefore, are not relevant portions of Anderson's overall circuit.

Even further, claim 7 depends from claim 6 and further adds that "the first and second impedance elements are capacitance impedance elements". This clearly is not taught by Anderson.

Even further, claim 8 depends from claim 6 and recites that the voltage divider "has a current blocking resistance in parallel connection with the conducting drain and source nodes of the switching transistor" and "the source of band control voltage is connected through a second resistor to the dividing point of the first resistance". There does not appear to be anything in Anderson that even remotely resembles the claimed structure, even in RF amplifier 9.

Accordingly, claim 1 and its dependent claims 2-8 clearly distinguish over the prior art of record for the reasons set forth above and should be deemed allowable.

Turning to independent claim 9, it contains essentially all of the same limitations discussed above in connection with claim 1 and, therefore, distinguishes over the prior art of record for all of the reasons discussed above in connection with claim 1.

Dependent claim 10 which depends from claim 9 further adds "the conducting drain and source nodes of the first switching transistor being in parallel connection with the second inductance impedance element to short the second inductance impedance element". Anderson does not appear to have anything that remotely resembles this circuit structure.

In the Office Action, the Office again referred to resistance 919 and transistor 901 of RF amplifier 9 with respect to claim 10. However, as noted above, RF amplifier 9 has nothing to do with tunable filter 7. Even if it did, it still does not meet the pertinent limitations as there does not

appear to be an inductance impedance element in RF amplifier 9 that is in parallel with any resistor in RF amplifier 9.

Claim 11 depends from claim 9 and further adds “a first resistance connected to a gate of the first switching transistor”, “the source of band control voltage being connected to a dividing point of the first resistance”, and “the conducting drain and source nodes of the second switching transistor being in series connection with the second capacitance impedance element to short the second capacitance impedance element”. There is nothing in tunable filter 7 of Anderson that appears to have any resemblance to these limitations. Again, in rejecting claim 11, the Office referred to components in RF amplifier 9, which has nothing to do with the tunable filter 7. Even considering RF amplifier 9, it clearly does not meet these limitations, in any event. Specifically, there does not appear to be any band control voltage connection in RF amplifier 9.

Referring to dependent claim 12, which, as amended, depends from claim 11, it recites that “the first resistance is a current blocking resistance in parallel connection with conducting drain and source nodes of the switching transistor”, and “the source of band control voltages connected through a second resistor to a dividing point of the first resistance”. Nothing like this is found in tunable filter 7. Even if we consider RF amplifier 9 to be relevant, it does not receive any band control voltage and, therefore, cannot possibly meet the limitations of this claim.

With respect to claims 13, 14, and 15, the Office asserted that “Anderson further discloses a switching transistor is a FET and a amplifier as disclosed in column 3 lines 25-26”. This passage of Anderson discusses the fact that the local oscillator 15 has a tunable filter and an amplifier. This statement with respect to claims 13, 14, and 15 is very vague and, therefore difficult to address in any meaningful way. For instance, local oscillator 15 is a separate circuit component

from either RF amplifier 9 or tunable filter 7 and does not appear to have any connection to tunable filter 7 or RF amplifier 9, except for the fact that a signal from RF amplifier 9 is mixed by mixer 14 with the output of the local oscillator 15 to generate the IF signal 17. The manner in which the Office believes that this has anything to do with what is claimed in claims 13-15 is entirely unclear. However, Applicant does point out that the Office's assertion with respect to claim 13 that Anderson discloses that the switching transistor is a FET does not appear to make any sense. First, the Office has already conceded that Anderson does not disclose a switching transistor. Rather, the Office is relying on a substitution of Liu's transistor for Anderson's switching diodes. Accordingly, the assertion that Anderson discloses that the switching transistor is a FET does not appear to make any sense. Further, even if we look to transistor 901 in RF amplifier 9, as somehow being relevant, Anderson expressly discloses that this transistor is a MOSFET, not an EFET.

Hence, for the reasons discussed above, the rejections of claims 1-15 should be withdrawn and these claims deemed allowable.

Applicant, in reviewing these claims has noted several clerical errors and has attempted to correct them with further claim amendments. For instance, some of the dependent claims referred back to certain resistors and transistors in a manner that was potentially confusing since multiple resistors and/or transistors had been recited in preceding claims. Applicant has amended the claims to eliminate possible confusion.

Finally, Applicant has added several new claims, 16-21, that recite additional features of the invention.

Application No. 09/450,912

Docket No. 17481

In view of the foregoing amendments and remarks, this application is now in condition for allowance. Applicant respectfully requests the Examiner to issue a Notice of Allowance at the earliest possible date. The Examiner is invited to contact Applicant's undersigned counsel by telephone call in order to further the prosecution of this case in any way.

Respectfully submitted,



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Marked Up Version of Claims

6. A dual band RF tuning circuit as recited in claim 1, and further comprising: a first resistance connected across [the] a [conducting] gate[s] of the switching transistor, the source of band control voltage being connected to a dividing point of the first resistance, and the conducting drain and source nodes of the switching transistor being in series connection with the second impedance element to open-circuit the second impedance element.

8. A dual band RF tuning circuit as recited in claim 6, wherein the [voltage divider has] first resistance is a current blocking resistance in parallel connection with the conducting drain and source nodes of the switching transistor, and the source of band control voltage is connected through a second resistor to [a] the dividing point of the [current blocking] first resistance.

9. A dual band RF tuning circuit comprising:
a first inductance impedance element and a second inductance impedance element between an RF input port and an RF output port,
the tuning circuit being tuned by the first and second inductance impedance elements to receive a first RF signal and to provide the first RF signal at the output port,
the tuning circuit being tuned by the first inductance impedance element alone to receive a second RF signal and to provide the second RF signal at the output port,
a first switching transistor being switched on and off by changing its bias voltage,
a band control voltage source connected to the first switching transistor to change its bias voltage,

the first switching transistor having conducting drain and source nodes connected to the second inductance impedance element to short the second inductance impedance element, which tunes the tuning circuit by the first inductance impedance element,

a first capacitance impedance element and a second capacitance impedance element between the RF input port and the RF output port,

the tuning circuit being tuned by the first and second capacitance impedance elements to receive a first RF signal and to provide the first RF signal at the output port,

the tuning circuit being tuned by the first capacitance impedance element alone to receive a second RF signal and to provide the second RF signal at the output port,

a second switching transistor being switched on and off by changing its bias voltage,

the band control voltage source connected to the second switching transistor to change its bias voltage, and

the second switching transistor having conducting drain and source nodes connected to the second capacitance impedance element to short the second capacitance impedance element, which tunes the tuning circuit by the first capacitance impedance element.

10. A dual band RF tuning circuit as recited in claim 9, and further comprising: [a current blocking resistance in parallel connection with the second inductance impedance element, and] the conducting drain and source nodes of the first switching transistor being in parallel connection with the second inductance impedance element to short the second inductance impedance element.

11. A dual band RF tuning circuit as recited in claim 9, and further comprising: a first resistance connected [across the conducting] to a gate[s] of the second switching transistor, and the source of band control voltage being connected to a dividing point of the first resistance, and the conducting drain and source nodes of the second switching transistor being in series connection with the second capacitance impedance element to short the second capacitance impedance element.

12. A dual band RF tuning circuit as recited in claim [9] 11, wherein the first resistance is a current blocking resistance in parallel connection with the conducting drain and source nodes of the second switching transistor, and the source of band control voltage is connected through a second resistor to a dividing point of the [current blocking] first resistance.

13. A dual band RF tuning circuit as recited in claim 9, and further comprising: the first switching transistor is an EFET transistor, and a further resistor is referenced to ground and is connected at the gate fo the EFET transistor.

14. A dual band RF tuning circuit as recited in claim 9, and further comprising: the output of the [switching transistor] RF tuning circuit being supplied to an amplifier at an input side of [the] a second dual band RF tuning circuit.